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Discovery of the biology of *Glyphipterix loricatella* (Treitschke, 1833) (Lepidoptera, Glyphipterigidae), a borer in *Iris* (Iridaceae)

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Abstract. The biology and larva of *Glyphipterix loricatella* (Treitschke, 1833) are described for the first time on the basis of material from two localities in Hungary, in the vicinity of Budapest. We reared larvae from *Iris* × *germanica* L. (Iridaceae), representing a new hostplant family for *Glyphipterix*. The larvae develop over a year in the leaves, later in the rhizome, where they spend the winter as mature larvae. The larvae eat themselves out of the rhizome in spring and pupate outside the rhizome in the soil in a cocoon, covered with soil particles. The pupal stage lasts 30–35 days. All developmental stages are illustrated.

Introduction

The genus *Glyphipterix* Hübner, 1825 contains globally 283 named species (Beccaloni et al. 2018), of which 62 species occur in the Palaearctic region (Diakonoff 1986). In Europe 19 species and two subspecies have been recorded (Agassiz 2013). The larvae of the European species of the genus feed on plants belonging to diverse families. The majority of hostplants belong to the monocots: Juncaceae three species; Cyperaceae three species and Poaceae one species, but two species feed on the eudicot family Crassulaceae. The host plants of nine European species are still unknown (Table 1). In Hungary, eight species are known (Pastorális et al. 2016), including the rare *G. loricatella* (Treitschke, 1833), whose biology was hitherto unknown.

Table 1. Host plants of the European *Glyphipterix* species.

Species	Host plants	Plant Family	Attacked plant parts	Pupation site	References
G. argyroguttella Ragonot, 1885	unknown	unknown	unknown	unknown	
G. bergstraesserella (Fabricius, 1781)	*Luzula luzuloides* Dandy et Wilmott	Juncaceae	mines in stem	in stem	Diakonoff 1986
G. danilevskii Diakonoff, 1978	unknown	unknown	unknown	unknown	
G. diaphora Walsingham, 1894	unknown	unknown	unknown	unknown	
G. equitella (Scopoli, 1763)	*Sedum album* L. *S. acre* L., *S. anglicum* Huds.(?), *Aeonium arboreum* (L.) Webb & Berthel.	Crassulaceae	mines in leaf and stem	in leaf and stem	Pelham-Clinton 1985, Schmalstieg and Kummer 2010

Species	Host plants	Plant Family	Attacked plant parts	Pupation site	References
G. forsterella (Fabricius, 1781)	*Carex remota* L. *C. vulpina* L.	Cyperaceae	seed	in seed	Pelham-Clinton 1985
G. fortunatella Walsingham, 1908	unknown	unknown	unknown	unknown	
G. fuscoviridella (Haworth, 1828)	*Luzula campestris* DC.	Juncaceae	stem	stem	Pelham-Clinton 1985, Diakonoff 1986
G. gianelliella Ragonot, 1885	unknown	unknown	unknown	unknown	
G. haworthana (Stephens, 1834)	*Eriophorum angustifolium* Honck. *E. vaginatum* L., *E. latifolium* Hoppe.	Cyperaceae	seed	in seed	Stainton 1870
G. heptaglyphella Le Marchand, 1925	unknown	unknown	unknown	unknown	
G. loricatella (Treitschke, 1833)	*Iris* × *germanica, Iris pumila* L.	Iridaceae	leaf, rhizome	in soil, in cocoon	this paper
G. nicaeella Möschler, 1866	unknown	unknown	unknown	unknown	
G. pygmaeella Rebel, 1896	unknown	unknown	unknown	unknown	
G. schoenicolella Boyd, 1859	*Schoenus nigricans* L. *Cladium mariscus* Pohl.	Cyperaceae	seed	in seed-head	Ernst 2010, Ernst and Niederbichler 2014
G. simpliciella (Stephens, 1834)	*Dactylis glomerata* L., *Festuca arundinacea* Schreb.	Poaceae	seed	in stem	Stainton 1870, Pelham-Clinton 1985
G. sulcosa Diakonoff, 1978	unknown	unknown	unknown	unknown	
G. thrasonella (Scopoli, 1763)	*Juncus* spp.	Juncaceae	mines in stem	in stem	Pelham-Clinton 1985, Diakonoff 1986
G. umbilici Hering, 1927	*Umbilicus rupestris* Dandy	Crassulaceae	leaf	unknown	Hering 1957

Conservation

Due to its overall rarity, *Glyphipterix loricatella* is listed in the Habitats Directive Annex II and Annex IV (Anonymous 1992). Its most characteristic habitats include calcareous dolomitic grasslands on hillsides, slope steppe grasslands, and semi-open karstic oakwoods with *Quercus pubescens* Willd. Due to urban development, these habitats have suffered severe areal loss. Threats include loss of grasslands via natural succession, illegal collecting of host plants, tramping down of habitats by vehicles and hikers as well as accidental fires.

Recently two local populations were discovered in Hungary: one in Törökbálint where the population size is estimated between 50 and 100 specimens, and one in Biatorbágy where only a handful of specimens has been found; the size of the last population is likely below 50 adults flying at any one time (Szabóky 2014). The aim of this article is to describe the hitherto unknown biology and developmental stages of *G. loricatella*, in order to assist further research and exploration of its habitat requirement, and a more effective protection of the species.

Historical overview

Treitschke (1833) described the species *Glyphipterix loricatella* (Fig. 1) under the name *Aechmia loricatella*, based on specimens caught in Hungary. He did not give the specific whereabouts, writing only that the first specimens were caught by Kindermann in "Ofen" (= Buda, part of Budapest). After Kindermann collected the species, it had not been found in Hungary for more than 50 years. Frivaldszky had no specimens in his extensive collection and he even failed to mention the species in his faunistic synopsis (Frivaldszky 1864, 1865).

Interestingly, Abafi-Aigner (1898) also neglected the species in his book; he only hinted that Kindermann sold specimens to Treitschke, who described some new species from Kindermann's material. At the end of the 19th century, the species was found again in the calcareous habitats of the Buda Hills and had been continuously collected there until 1971 (Kun and Szabóky 1999). According to the Hungarian Red Data Book (Varga 1990), the last record of the species originated from the year 1971, and the species was considered close to being extinct.

The species was rediscovered by Csaba Szabóky in 16 May 1996 in Fenyőgyöngye, Buda Hills (Szabóky 1996). As a result of his intensive research, it was found later in other nearby localities in the Buda Hills (Hármashatár-hegy, Újlaki-hegy, Mátyás-hegy) and the Pilis Mountains (Nagy-Kevély).

The species was recorded also from Romania (Transsylvania, Tordai-hasadék) (Capuşe and Kovacs 1987), Serbia (Meess and Spuler 1910), Albania (Agassiz 2013), and from the coastal Mediterranean parts of the Crimea (Savchuk 2013). There are no published host records for this species (Treitschke 1833, Gozmány 1955, Diakonoff 1986, Varga 1990).

Material and methods

The species was found, surprisingly, in a cottage garden in Törökbálint by Gergely Szövényi, a professional entomologist who recognised this species. Following his information, we found more specimens in his garden, 90% of which were sitting on the leaves of cultivated garden Iris, *Iris* × *germanica* L., so we supposed that this plant could be among its host plants. Our assumption was supported by another observation in Csepel (Budapest), where a moth was also found sitting on *Iris* × *germanica*.

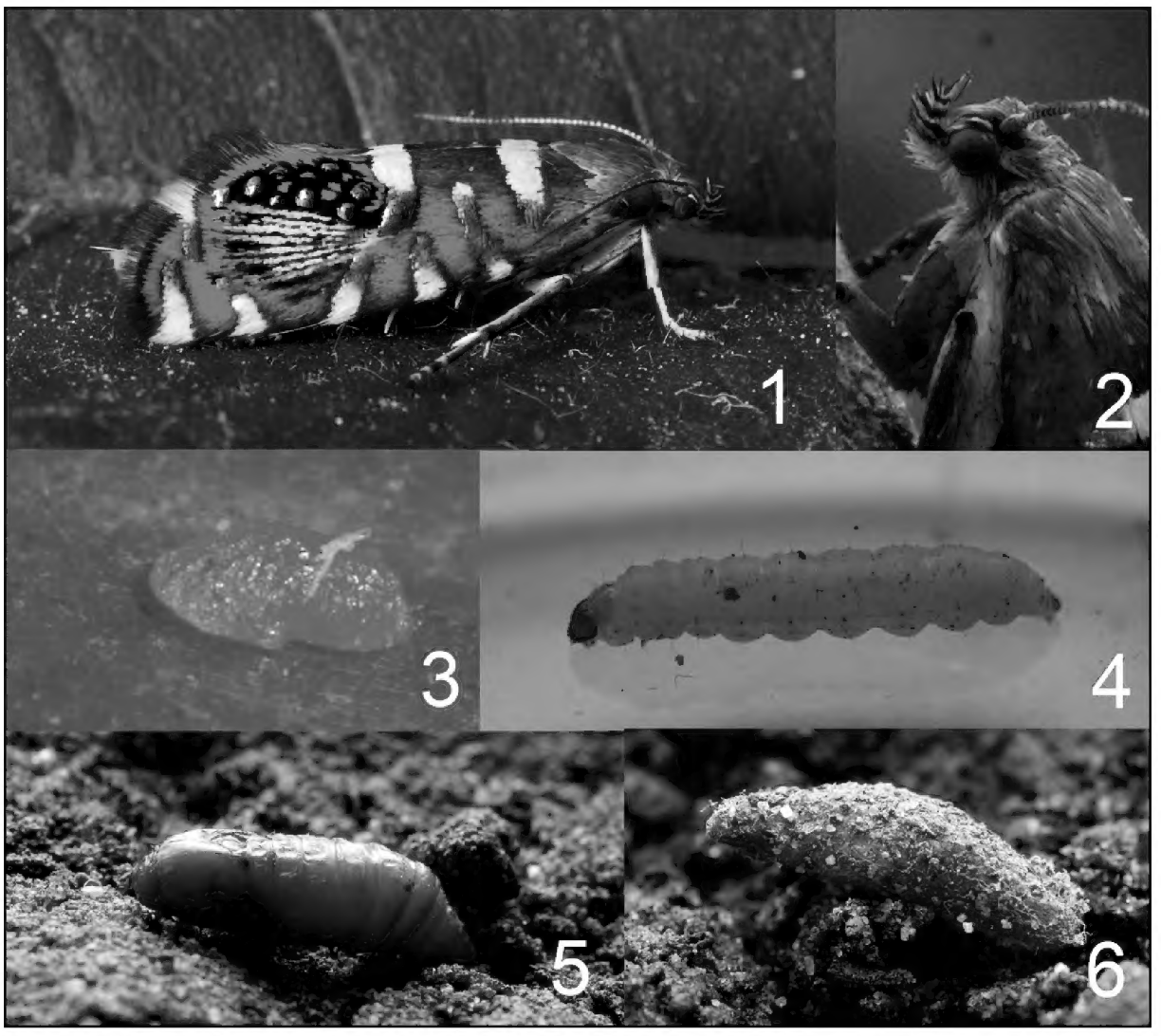
We collected a female specimen in Törökbálint on 17 May, 2013, as soon as it finished copulating. We planted three stock plants of *Iris* × *germanica* in an insectarium (80×80×100 cm) and placed the moth therein. The insectarium was kept at room temperature (ca 20 °C). The moth laid ten eggs in total, each singly on a leaf of *Iris* × *germanica*. After oviposition, the imago was taken back to its original habitat, as for the ten reared moths that emerged in 2014.

Results and discussion

Glyphipterix loricatella is the largest species of the genus occurring in Hungary with its wingspan 17–19 mm (Gozmány 1955). The black and white palp is thickened by scales, forming a roughly projecting, whorl-like fringe below (Fig. 2). The forewing ground colour is ochreous-brown of various shades, darkest along dorsal margin, which is often dark grey-brown or chocolate-brown. The forewing pattern is characteristic, the costa having five conspicuous white stripes and the inner margin with two, which continue in the shining metallic silvery-plumbeous grey sections (Figs 1, 2). The outer half of the wing has a large blackish patch distal of the cell, which is strigulated with fine horizontal white lines, a few ochreous-brown spots and nine rounded silvery-blueish dots below. The fringe is long, dark brownish-grey, with a fine white stripe in the middle, this stripe is continued towards the termen as a thin silvery-plumbeous grey line.

Host plant

Based on observations of the behaviour of the *G. loricatella* specimens examined in their habitat in Törökbálint, we can infer the natural hostplant.



Figures 1–6. 1. Adult, 18.iv.2014, Budapest. **2.** Detail of head, showing labial palpi, 18.iv.2014, Budapest. **3.** Egg, 18.v.2013, Budapest **4.** L4 Larva before pupation, 24.iii.2014, Budapest. **5.** Pupa, 01.iv.2014, Budapest **6.** Cocoon with pupa inside, 01.iv.2014, Budapest.Photos by Attila Takács, Fig. 3 by Zsolt Bálint.

Iris pumila L grows on limestone substrate in the natural habitat of the moth. However, we observed egg laying on *Iris* × *germanica*. This is a garden cultivar, which does not occur in nature, so we presume the native hostplant of *G. loricatella* is *I. pumila*. This assumption is supported by the fact that in the habitat of the species at the Hármashatár-hegy (Buda Hills), where the species was re-discovered in 1996, *I. pumila* is the sole *Iris* species. Surprisingly however, we have not yet observed larvae nor damage on this plant species, but perhaps natural damage is at low density.

Preimaginal stages

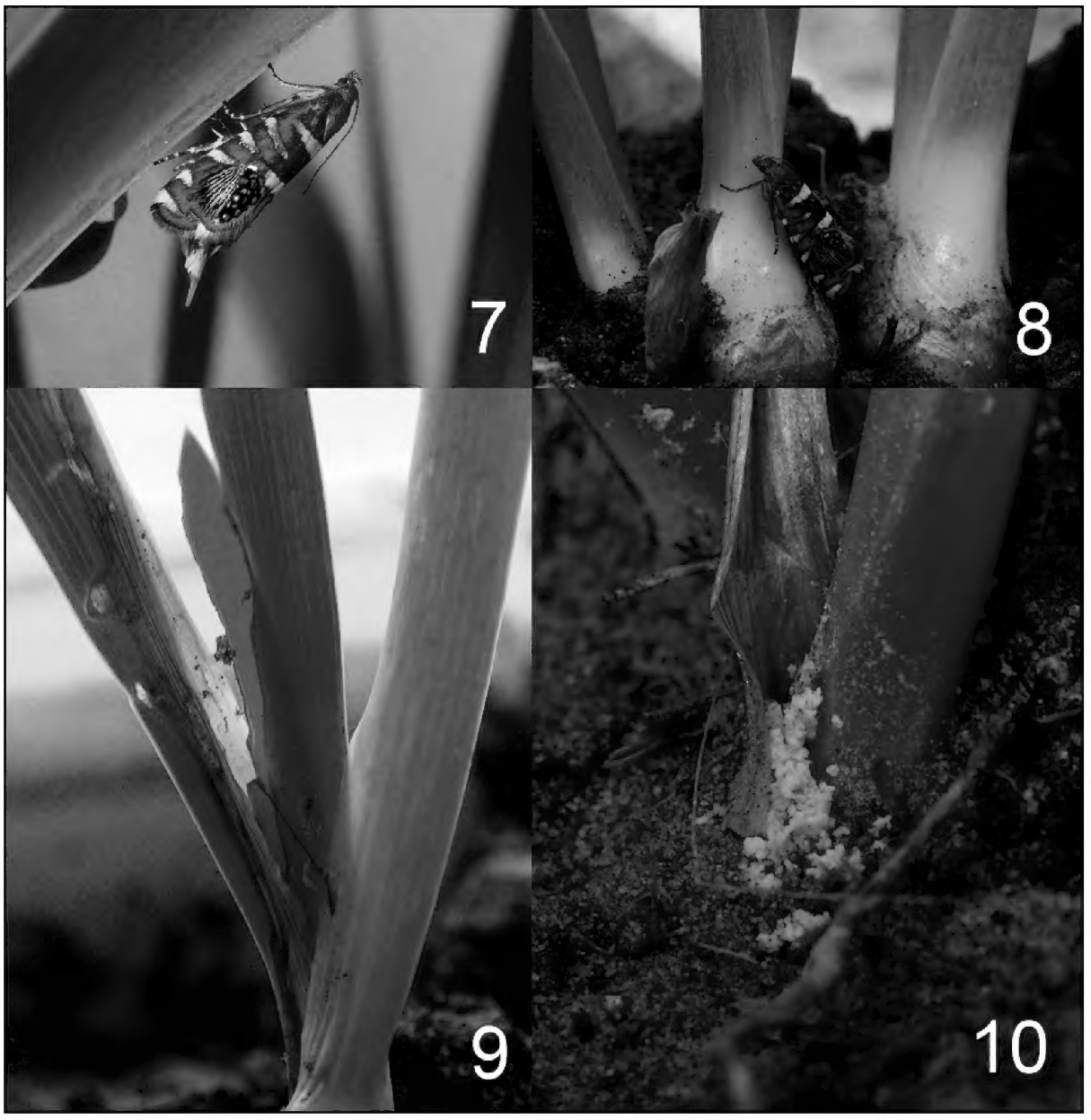
Ovum. Elliptical, yellow; width 0.2 mm, length 0.6 mm (Fig. 3).

Larva. There are four larval instars. L1–L4 larvae are white, with head black, length of instar L4 is 40 mm (Fig. 4). The L1–L2 instar larva mines in the leaf, while the L3 instar feeds in the rhizome. The L4 instar overwinters sheltering in the rhizome and leaves it in mid-April or the end of April, depending on the actual weather conditions.

Pupa. Brown, length 10 mm (Fig. 5), lying in the soil 50–100 mm under the surface in a cocoon (Fig. 6), to which soil grains stick. The pupal stage lasts 30–35 days.

Bionomics

The typical habitats of *G. loricatella* are clearings in shrubby karstic oakwoods and xerothermic rocky grasslands on calcareous ground, where its hostplant presumably is the sub-Mediterranean



Figures 7–10. 7. Female releasing sex pheromone, 17.v.2013, Törökbálint 8. Ovipositing Female, 18.v.2013, Budapest **9.** Leafmine in *Iris* × *germanica*, 18.vi.2013, Budapest **10.** Larva pushing excrements out of rhizome of *Iris*, 01.vii.2013, Budapest. Photos by Attila Takács.

Iris pumila. The adults are on the wing from the beginning of May to the beginning of June. According to our field monitoring data, the male specimens emerge 7–10 days earlier than the females. Males are likely to wander, while females tend to sit on the leaves of the hostplant or some other plant in the vicinity. The adults do not feed. Females start to release sex pheromones (Fig. 7) between 7 and 8 a.m. and they usually continue calling until 10 a.m., if copulation does not occur. Mating lasts for 45–90 minutes.

Fertilized females climb on the hostplant, and only very rarely fly from one plant to another during oviposition behaviour (Fig. 8). They lay the eggs one by one on the leaves of the plant, 3–8 centimetres above the rhizome, with 2–4 eggs on each plant. The larvae emerge after 10–12 days and burrow into the leaves and make a mine (Fig. 9), leaving their frass behind in the mines. The L3 instar larvae reach the rhizome through the leaf and continue feeding there. A number of (2–4) larvae can feed simultaneously in the same rhizome. Larvae push their excrements out of the rhizome (Fig. 10).

Due to unknown reasons, not every larva reaches the rhizome through the leaf, but some vacate the leaf instead and descend to the rhizome by means of silken threads and thence burrow into the rhizome. The larva spends the winter inside the rhizome.

The larva leaves the rhizome in April and, not far from it, spins a cocoon in the soil, covered with soil particles, 50–100 mm under the surface, where it will eventually pupate. Moths emerge 30–35 days after cocoon-making.

The rearing experiment ended with 100% success, every egg (10) developing into an adult.

Conclusions

It was very fortuitous that a viable population of the species could be found in an urban environment. The rhizomes of *Iris pumila* in Fenyőgyöngye (the natural habitat of the moth discovered in 1996) were eaten by boars (*Sus scrofa scrofa* L.) in the winter of 1998–99, and therefore the species can be considered as probably extinct from that locality.

Our aim with this article has been to present the biology and developmental stages of the species *G. loricatella*, to assist further research and discovery of new habitats, and, using the new information, to allow more effective protection of the moth in the future. Our future work is to find new habitats, so that we can map the moth's range in detail, primarily in Hungary.

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